

**Before the
Federal Communications Commission
Washington, D.C. 20554**

In the Matter of)	
)	
Revision of Part 15 of the Commission's)	ET Docket 98-153
Rules Regarding Ultra-Wideband)	
Transmission Systems)	

REPLY COMMENTS OF KROHNE, INC.

Krohne, Inc. ("Krohne") by its attorneys, hereby files these reply comments in the above-captioned proceeding. Krohne is a leading worldwide manufacturer of tank level radar technology and will be directly affected by the outcome of this proceeding.

As Krohne explained in its comments, Krohne manufactures a fluid level measuring device that uses FM emissions sweeping between 8.5 - 9.5 GHz within enclosed metal tanks. There has never been a report of interference from one of the Krohne devices. Nevertheless, pursuant to waivers obtained with the consent of NTIA, Krohne and its each of its customers are tethered to a Part 90 conditional site license and further licensing processes for every installation. It is Krohne's position that the UWB proceeding represents an opportunity for the Commission to recognize this and similar inequities in its processes and permit the operation of Krohne devices pursuant to Part 15. By doing so, the Commission would help speed new technologies to the market and create a level playing field for manufacturers who have developed spectrum efficient technologies.

The Commission should adopt a more flexible definition of UWB. Krohne observed in its comments that the proposed definitional limit of UWB devices to 1500 MHz of bandwidth is clearly a somewhat arbitrary figure and would effectively penalize spectrum efficient technologies that are able to make use of lesser bandwidths, while still placing little or no RF energy into the restricted bands. Krohne's position was echoed by others in this proceeding. Delphi Automotive Systems Corporation observed that: "...the Commission should broaden its definition of UWB by modifying its proposed bandwidth

and waveform requirements. The Commission should modify its proposed definition of UWB because it would preclude narrower band wave forms with emission levels lower than devices the Commission purposes to approve...” As Delphi quite properly notes, otherwise, “...companies that have been producing radar sensors under the Commission’s current rules would be disadvantaged, and consumers will not benefit from improvements in existing technology.” Dephi suggests the Commission broaden its UWB definition to include devices that occupy 500 MHz or more of spectrum, regardless of center frequency. Krohne agrees.

The Commission should permit swept frequency devices. A Krohne competitor, Endress + Hauser, a manufacturer of pulsed technology equipment, has offered the gratuitous comment that linear sweep FM should not be included in the definition of UWB. Clearly seeking to insure an advantage for its own products, Endress + Hauser explains, “Frequency Modulated continuous Wave (“FMCW”) systems emit continuous emissions because a center frequency is shifted very slowly across a narrow bandwidth. The cumulative impact of this linear sweep could result in possible background noise, making it very dissimilar from true UWB systems.” These self-serving comments, completely unsupported by any technical submission, represent not only bad policy, but bad science. Endress + Hauser posits a very slow sweep across a narrow bandwidth. What an odd set of presumptions in a proceeding designed to elicit useful comments on UWB systems. Clearly, under some circumstances an FMCW device could result in background noise. But, of course, so could a pulsed device.

As Krohne pointed out in its comments, the Commission should temper its concern over forms of modulation and precise bandwidths by considering the nature of the transmitter, in Krohne’s case, a low power transmitter within a sealed steel tank, and the victim receiver, which in the 8.5 to 9.5 GHz band is designed to receive the transmissions of high power radiolocation devices.

Krohne is submitting, as Attachment A, an analysis of the effect of swept FM equipment on receivers by Isidore Strauss of Curtis- Straus Laboratories. As Mr. Straus

explains, depending on their operating characteristics, FM UWB systems will produce effects on receivers comparable to pulsed systems that would be permitted under the Commission's proposals. And the effect on receivers, of course, should be the Commission's primary concern, not the form of modulation of a transmitter.

Many fluid level measuring devices should be treated like GPR and through-wall imaging systems. The Commission has clearly indicated that it will give special consideration to GPR and through-wall imaging systems. These systems direct their transmissions into the ground or into walls or floors where much of the energy is absorbed. Thus their interference potential is very low. Krohne's fluid level measuring device directs its transmissions into the substance being measured and is confined in a steel tank. Thus, its interference potential is similarly very low.¹ Again, as noted above, the potential interference to a victim receiver should be the Commission's primary concern. Where it can be shown, by the very nature of the device, that there is little or no chance of such interference, the Commission should permit its operation under its UWB regulations.

The Commission should "fast-track" non-communications UWB consideration. Krohne urges the Commission to bifurcate the UWB proceeding now. Even though the Commission is still awaiting test results from NTIA and others, it should separate its consideration of GPR, through-wall imaging systems and any other non-communications low power UWB technology, such as Krohne's, from the rest of the Docket and proceed on a fast track.

Bifurcation and fast-tracking will serve the public interest and simplify the Commission's burden of sifting through the myriad and often contradictory filings in the general UWB proceeding. The technologies in question, are easily understood and do not require the years of study and debate that will surely accompany the Commission's deliberations on UWB communications devices. The Commission should be prepared to

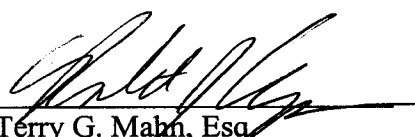
¹ Krohne's devices are also used to measure within fiberglass and other non-metal containers. It is not addressing its remarks here to these uses.

consider separately, and act on requests to manufacture and sell devices that employ very low power, are not ubiquitous, either in time or location of operation, whose emissions are either absorbed or confined, and which pose no realistic interference threat to licensed services.

Krohne also recommends that the Commission grant the Chief, Office of Engineering and Technology, delegated authority to act on waivers of its rules to permit the earliest introduction of this class of devices. Although waivers have been possible in the past, the Commission has had to engage in lengthy coordination with the NTIA when UWB devices transmitted over restricted bands. A separated proceeding, concentrating on the low powered devices described above, should provide the Commission with sufficient information and confidence to act more expeditiously.

Conclusion. Krohne appreciates the opportunity to express its views in this proceeding and stands ready to supply the Commission with whatever further information it requires. Krohne believes that the UWB proceeding can effectively be a significant deregulatory step that can result in more competition and the production of new and useful RF devices. Krohne urges the Commission to take the flexible approaches it has recommended here.

Respectfully submitted,
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October 27, 2000

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ATTACHMENT A

October 24, 2000

Comments on FCC Ultra-Wideband NPRM (FCC 00-163) Relative to Linear
Swept FM Devices

Introduction:

I am submitting my comments in response to the Notice of Proposed Rule Making (NPRM) on Ultra-Wideband Devices (UWB), FCC 00-163, which proposes rules for the definition and regulation of UWB equipment. In the NPRM, the FCC states that the proceeding is tailored to UWB devices utilizing pulsed technology. The FCC requests comments on whether UWB devices should be limited solely to pulsed devices, or whether other types of modulation, such as linearly swept FM should be included. These comments address that issue, and support the inclusion of linearly swept FM equipment by discussing circumstances where their effect on received signals is equivalent to that produced by some of the pulsed signals the FCC has included in its NPRM.

Discussion:

In the NPRM, the FCC discusses many different types of UWB systems and highlights many possible applications. The focus of the discussion is on pulsatile systems which occupy a wide bandwidth by virtue of their use of high intensity, short-duration pulses. Some of these pulses are base-band (no carrier), while others utilize a pulsed RF signal.

The wide bandwidth of these pulsed systems is generated by virtue of the pulses' fast rise time and short duration. As a consequence, these systems are characterized by a high ratio of peak to average signal level. In its NPRM, the FCC discusses such issues as the appropriate signal levels, the measured bandwidth, the measurement methods, and perhaps most fundamentally, the definition of UWB systems.

Tentatively, the FCC would define UWB systems as those occupying an absolute bandwidth of at least 1.5 GHz, or a bandwidth to center frequency ratio greater than or equal to 25%. The FCC points out that its discussion of UWB devices has been largely framed in terms of pulsed equipment, but it notes (para. 21 of the NPRM) that other types of modulation, including linear swept FM, are capable of producing UWB equipment. The FCC states:

We also request comment on whether we should define UWB devices as limited to devices that solely use pulsed emissions where the bandwidth is directly related to the narrow pulse width. We recognize that other types of modulation, such as linear sweep FM, could be employed to produce UWB equipment.

These comments address that issue. We show that a continuously swept device (FMCW) can be operated so that it has a similar effect on receiving equipment as some of the pulsed equipment that is being included in the NPRM.

Under the FCC's proposed regulations, pulsatile systems face both "average" (defined operationally in paragraph 50 of the NPRM) and true peak limits (discussed in paragraphs 51 through 54).

The "average" levels are those measured with a 1 MHz receiver and video filtering. These measurements will be the result of a combination of three factors—(1) duty cycle of pulse transmission, (2) pulse desensitization effects due to the finite rise time of the measurement receiver, and (3) the degree of post detection video filtering employed in conjunction with peak holding readout. The resulting measurement is compared to the default field strength requirements of FCC para. 15.209, namely 500 uV/m at a test distance of 3 meters (for signals above 960 MHz). In addition, there is a maximum true peak to average specification imposed.

I would like to show that FMCW devices fit into this framework by focusing on the effect that they have on an affected receiver. As noted above, pulsed signals achieve their wide bandwidth by virtue of fast rise times and high peak to average ratios. For continuous FM signals, the power output does not vary, but the frequency varies continuously and rapidly. The FM signal of an FM UWB system is moved over the full bandwidth, spending a short time in any one place.

The output from a receiver varies greatly as the signal is swept through it. In fact, the output is a pulse whose duration is set by the rise time of the receiver and the sweep rate of the FM system. The rate of FM sweep relative to the defined averaging characteristics is a key parameter in determining the “peak” (unswept) to average ratio. This ratio can serve the same purpose in protecting communications from swept FM systems as the peak to average ratio does for pulsed systems.

Let us review the key ideas behind the FCC’s proposal, which is focused on pulsed systems, and see how they could be applied to FM UWB systems. There are four main issues:

1. *Field Strength Limits:* The basic field strength limit is still that of Section 15.209, i.e., 500 $\mu\text{V/m}$ @ 3m (or 54 dBuV/m in logarithmic terms). This is stated in terms of a continuous signal, but the FCC also states in the NPRM that this implies an energy density limit, since the bandwidth of the measuring instrument is specified (1 MHz above 1 GHz). Therefore (at high frequencies) the implied field strength limit density is 54 dBuV/m .
2. *Bandwidth of Protected Communications:* The FCC states that there is a wide variation in the width of communications channels. It states an upper limit of 50 MHz, and implies a more common limit of 1 MHz. Obviously, there are also much narrower channels (e.g. cellular telephone channels) but the regulations are built around the 1 MHz figure.
3. *Measured Bandwidth and Averaging Techniques:* Although some of its commenters had suggested the use of several different measurement bandwidths to protect different types of communications channels, the FCC stuck with a 1 MHz resolution bandwidth in the interests of simplicity and commonality with other measurements. It combined this with a requirement that “average” detection be defined as the highest measurement made with a spectrum analyzer/receiver in peak-hold mode using a video bandwidth in the range of 10 Hz to 10 KHz in combination with the above mentioned 1 MHz resolution (IF) bandwidth. (It should be noted that the rationale for the 10 Hz lower bound on video cutoff frequency was not discussed in the proceeding. The lower this frequency is, the closer the measurement comes to a true average. Many

current spectrum analyzers incorporate video filters that can be set to a bandwidth as low as 1 Hz.)

4. *Pulse Desensitization:* Pulse desensitization is a compensation applied to the measured signal which accounts for the rise time of the measuring instrument. The typical rise time of a receiver, in the absence of additional video filtering, may be estimated by the formula $t_r = .35/\text{RBW}$. For example, in the case of a 1 MHz resolution bandwidth, we would have $t_r = 350$ nanoseconds. For pulses narrower than this, the measurement instrument will not have time to stabilize to the true levels, so measured levels will be significantly lower than those present. Most commenters suggested ignoring pulse desensitization, stating that the important issue was the response of a standard receiver rather than a calculated instantaneous field strength. The FCC agrees partially—it will not require pulse desensitization calculations, but in order to prevent receiver overloading due to intense fields, it will apply a (fairly generous) maximum ratio of up to 60 dB on peak pulse to average levels, depending on occupied bandwidth. Here peak is defined as either the true peak as measured in the time domain with sampling oscilloscopes, or in the frequency domain with a wide bandwidth (50 MHz) microwave receiver.

How could FM swept systems be incorporated into this framework? The key factor is to observe that the measure of interference is the unwanted output of the affected receiver. We suggest that if it can be shown that there are operating conditions for FM UWB systems which produce receiver outputs indistinguishable from those produced by pulsed systems, then they should be included in the family of devices covered by the UWB initiative.

For pulsatile systems, we have the following situations depending on repetition rate, regularity, and frequency stability:

- a) For rapid (i.e., $\text{RBW} < 0.3$ pulse repetition rate), fairly regular pulses, we have a continuous line spectrum. The level measured will be insensitive to the degree of averaging (i.e., post detection video bandwidth).
- b) For pulses with a repetition rate significantly slower than the RBW, we will have an impulsive spectrum whose “average” measured level will be highly sensitive to the receiver response time.. Note that in the limit of extensive video

filtering (low frequency video filter) the measured average will approach a true average of the signal level within the receiver passband.

c) For pulses that are fairly rapid (average rate relative to RBW), but irregular due to position modulation, we will have a spectrum which “looks” like noise, and will also be sensitive to video bandwidth.

d) A “hybrid” system can also be imagined where a rapidly pulsed system of type (a) above is operated intermittently producing slow pulsing of a continuous spectrum. This might be done to save power between regularly spaced measurement operations.

To a receiver, the output resulting from a widely swept FM signal is most like case (b) or (d) above. As the signal sweeps across the fixed receiver channel, an output pulse is produced. It can be seen that

a) The averaged output of the receiver under continuous swept FM conditions is identical to the averaged output of the receiver under slow pulsed conditions provided that the time the swept signal spends within the receiver channel is equal to the on time of the pulsed signal, and

b) The actual level of the FM signal sans modulation stands in the same relation to the average receiver output in the FM case as the peak pulse level does to the average receiver output in the pulsed case. Even though the FM signal amplitude is strong, it is within the passband of the receiver for a very short time. The duty cycle of the time it spends in the receiver passband is the ratio of the resolution bandwidth to the total swept bandwidth. For example, if one takes a 1 MHz bandwidth as the RBW, and uses a 1.5 GHz sweep, the ratio of actual carrier to average carrier level received (neglecting speed of sweep issues) is 1/1500, a ratio of -63.5 dB. If one takes 50 MHz as the RBW and uses a 1.5 GHz sweep, the ratio is 1/30, a ratio of -29.5 dB.

For FM systems, the “average” measured can vary considerably in relation to the true average depending on the relationship between the level of video filtering allowed (video frequency filter cutoff) and the sweep rate of the FMCW system. In this regard, the FCC may wish to consider, as noted above, whether the lower 10 Hz video filtering limit suggested in FCC 00-163 is truly optimal, or whether a lower figure which provides more averaging can be considered. In the NPRM, the FCC points out that in other portions of

Part 15, a 100 mSec averaging "window" is used. The 10 Hz video filter corresponds to not a window, but a single-pole linear filter time constant of approximately 16 milliseconds. Sweeps that are "slow" in the sense of crossing the 1 MHz receiver window in a time interval comparable to the video filtering time constant will gain the benefit of any averaging, while more rapid sweep rates will approach as an upper bound the averaging factors described above.

Thus, we see that a rapidly swept FM unit produces effects on a test receiver comparable to those produced by some pulsed systems. The duality is that the "duty cycle" of the swept FM unit is in the frequency domain rather than in the time domain produced by the on/off behavior of a pulsed unit. The receiver can not tell the difference between on/off behavior in its passband due to amplitude pulsing of a signal or due to movement of frequency. Since there is a similarity in interference effects, it would be reasonable for extend the UWB proceeding to include swept FM devices under appropriate conditions of operation.

Respectfully,

A handwritten signature in black ink, appearing to read "I. Straus".

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